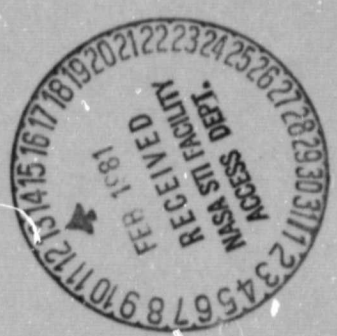
JPL PUBLICATION 80-79

FBI Fingerprint Identification Automation Study: AIDS III Evaluation Report

Volume VII: Top Down Functional Analysis



August 15, 1980

Prepared for
U.S. Department of Justice
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Through an agreement with
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CONTENTS

SECTION I

INTRODUCTION

This document presents the Top Down Functional Analysis of the Identification (ID) Division at the Federal Bureau of Investigation (FBI). As a separate activity, the functions of the ID Division are also being analyzed as a process. The results of that analysis will be reported elsewhere.

The functions enumerated in this analysis will be incorporated with the performance requirements and measures of effectiveness determined by another subtask in the FBI study task. To this will be added anticipated future functions and the results will be published as a functional requirements document. The functional requirements will be used as a basis for the AIDS III feasibility evaluation and to judge the alternate system concepts developed in the second phase of the study. See Reference 1 for an overall plan of the task.

SECTION II

TOP DOWN FUNCTIONAL ANALYSIS

The Top Down Functional Analysis is represented in chart form by a tree. Each branch of the tree is subdivided to show the lower level functions that need to be performed in order to accomplish the higher level function. In other words it is a hierarchical presentation of the functions required to perform the top level objective.

The top level of the tree is shown in Figure 2-1. The tree in detail is shown in the Appendix. On the tree diagram, the symbol @ indicates a function that is a candidate for automation. If all subfunctions of a function are candidates for automation, then the function itself is also a candidate and so on up the tree until one or more subfunctions are not candidates. In this case the candidacy cannot be propagated any further.

The symbols ① , ② , and ③ indicate that a function has been automated in the AIDS I or II system or is planned to be automated in the AIDS III system.

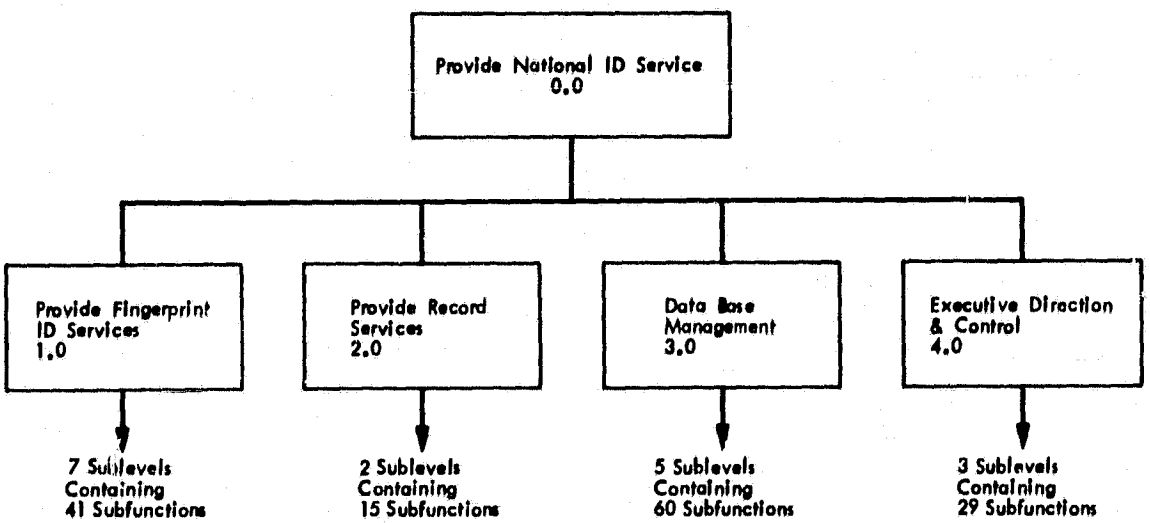


Figure 2-1. Diagram of Upper Level of Top Down Functional Analysis

SECTION III

DESCRIPTION OF THE TOP DOWN FUNCTIONAL ANALYSIS

This section describes the Top Down Functional Analysis charted in the previous section. Each element of the tree is described by a paragraph. The paragraph numbers refer to the element numbers in the tree.

0.0 Provide National Identification (ID) Service

The top of the functional analysis tree is titled to indicate the basic objective of the Identification Division of the FBI. This basic objective is subdivided into the four functions that are required to achieve the objective. These are: Provide Fingerprint Identification Services, Provide Record Services, Data Base Management, and Executive Direction and Control. These functions will be described and further divided in the following paragraphs.

The four second level functions can be grouped by the two services to outside agencies, identification and record services, and the two supporting functions, data base management and executive direction and control.

1.0 Provide Fingerprint Identification Services

This major branch of the tree contains all of the functions that relate directly to personnel identification by means of fingerprints. This includes identification of latent prints as well as prints of all 10 fingers rolled on a fingerprint (f/p) card.

This function divides into two subfunctions, Provide Positive Identification and Transmit Data.

1.1 Provide Positive Identification

The term positive identification is used to indicate the unique identification provided by fingerprint identification as opposed to ambiguous identification that can result from using only a person's name.

This function divides into three at the next lower level. These are: Search Personal Characteristics File, Match Characteristics, and Verify Identification.

1.1.1 Search Personal Characteristics File

To aid in the accurate and efficient search of the file, all personal characteristics available are used in the search. As will be seen later, the fingerprints will be used to establish the uniqueness of the matching in the verification process.

This function divides into: Obtain Input Data, Select Search Arguments, and Retrieve Candidates.

1.1.1.1 Obtain Input Data

This function is divided into three subfunctions: Collect (1.1.1.1.1), Receive (1.1.1.1.2), and Convert Data (1.1.1.1.3). The distinction between collecting and receiving data is made to indicate that the ID Division participates in the collection of data, as in the case of latent prints sent to the laboratory for processing, and also receives data collected by other agencies.

1.1.1.1.3 Convert Data

This function divides into the input of descriptors (1.1.1.1.3.1), that is the entry of physical and personal data in alphanumeric form into the data base, and the reading of fingerprint cards (1.1.1.1.3.2).

1.1.1.1.3.2 Read f/p Card

This function breaks down into eight subfunctions (1.1.1.1.3.2.1 through 1.1.1.1.3.2.8) that are self explanatory. Note the @ symbol indicates a function that is a candidate for automation.

The Register f/p function is further divided into three subfunctions; find the core (1.1.1.1.3.2.6.1), rotate the fingerprint (1.1.1.1.3.2.6.2), and scale the size (1.1.1.1.3.2.6.3).

1.1.1.2 Select Search Arguments

Depending on the input data available, its quality, and its rarity or commonness, a set of search arguments is selected. For example, not all 10 fingerprints may be available, especially in the case of latent prints. Some physical or personal data may be missing or may be of little use in the search since it does not significantly narrow the target file.

Consequently, the selection of arguments is further divided into: Classify f/p (1.1.1.2.1), Select f/p (1.1.1.2.2), Evaluate Descriptors (physical and personal characteristics) (1.1.1.2.3), and Select Descriptors (1.1.1.2.4).

1.1.1.3 Retrieve Candidates

The breakdown of this function is identical to the Access Data function described in 3.1.3.3.1 and therefore is not further elaborated here.

1.1.2 Match Characteristics

This function divides into three subfunctions, namely Apply Match Criteria (1.1.2.1), Collect Results (1.1.2.2), and Make Final Match (1.1.2.3). Both the application of match criteria and the collection of results are further divided into two subfunctions each.

1.1.2.1 Apply Match Criteria

This function consists of calculating correlations of the descriptors and the minutiae of all entries in the target file.

1.1.2.2 Collect Results

After the correlations have been calculated, they are filtered to narrow the search to the most likely and a threshold is tested to further narrow the choice.

1.1.2.3 Make Final Match

The next step in identification is to narrow the candidates to one that will be verified as a true identification or to reject all surviving candidates and declare no identification resulting from the search.

1.1.3 Verify Identification

This function and its two subfunctions are not candidates for automation because it is a policy that a human must make the final verification of the identification.

1.2 Transmit Data

After an identification has been made, the fact is transmitted. The fact that no match was made is also transmitted if that is the case. In order to do this, a verification of the legality (1.2.1.1) and the correctness (1.2.1.2) of the response is performed. In many cases the fact of identification is passed to the record service function described in 2.0.

The ID Division also provides expert witnesses to testify to the validity and uniqueness of the identification (1.2.2).

2.0 Provide Record Services

This second major branch of the tree contains all the functions related to the provision of personal history data connected with fingerprint identification. For example, arrest record, military service, etc.

This function breaks down into four subfunctions as shown in the chart.

2.1 Screen Requests

Requests fall into two major categories: criminal and applicant. Criminal requests are requests by law enforcement agencies for information about persons who have been apprehended or who are the subjects of investigations. Applicant requests are made by authorized agencies who seek background checks on persons applying for licenses and employment that require such a check.

2.1.1 Reject Unauthorized Requests

Unauthorized requests are rejected so that unnecessary searches need not be performed. Both this function and the following one are human activities and are not candidates for automation.

2.1.2 Establish Correct Selective Response

All information disseminated by the ID Division must be verified to be sure that the subject's rights and privacy are being protected and that the information is accurate. This includes consideration of how much information (selective response) an agency or individual is entitled to. For example, a charge of a crime which is more than one year old and for which no disposition of the charge (e.g., guilty, innocent, dropped,...) has been received may not be divulged to non-law enforcement agencies.

2.2 Retrieve Record

This function is divided into three subfunctions.

2.2.1 Provide Access Key (Name, FBI No., Social Security No., etc.)

When identification has been performed by some other authorized agency (e.g., local police force), it may be appropriate to provide access to file information in the absence of positive identification and verification by the FBI. (Currently, this access is provided by name or FBI number.) In this situation, the response will indicate the lack of an FBI fingerprint verified identification.

2.2.2 Associate Individual Fingerprint Identification with Record

When an identification is made based on fingerprints rather than name, FBI number, etc., the association between the input fingerprint card, the in-file fingerprint card, and the historical record must be made.

2.2.3 Access Data

This function is identical to the function described in 3.1.3.3.3 and is described there.

2.3 Provide for Flags/Stops

Stops (missing persons, criminals, fugitives, parole violators, etc.) are flagged so that future inquiries against their records will trigger an appropriate response.

This function breaks down into three subfunctions.

2.3.1 Set Flags

Stops for missing persons and subjects being sought by law enforcement agencies are recorded in the criminal file.

2.3.2 Identify Previously Set Flags

When a request is made for information about a person with a stop notice, the ID Division is responsible for seeing that the agency placing the stop with them is notified. The priority for notification from high to low is: flash notices, wanted, and missing.

2.3.3 Remove Flags

When the person is found or no longer sought, the flag is removed.

2.4 Respond to Inquiries

Information supplied by the ID Division must conform to response guidelines that balance the rights of the individual against the national interest and the need to have criminal history information. Law enforcement agencies are entitled to receive a complete criminal history. Responses to applicant requests do not receive arrest information that is more than a year old unless the disposition of the arrest has been received. Records of non-serious offenses are not kept by the ID Division.

2.4.1 Furnish Individual Criminal Record

On request from an authorized agency, arrest and disposition information is provided. This information is also furnished to authorized agencies performing background checks.

2.4.2 Indicate Absence of Criminal Record

Based on an inquiry from an authorized agency, the absence of a record is indicated when none is found.

2.4.3 Verify Response

Because of the vital importance of accurate reporting, any matching of personal characteristics with file data must be independently verified.

3.0 Data Base Management

This major function comprises all the functions needed for the operation of the file that supports both the identification service and the record (personal history) service. It breaks down into two subfunctions: Maintain Files and Monitor and Control the File.

3.1 Maintain Files

This function is divided into four functions: Receive Records, Store Records, Access Data, and Update Records.

3.1.1 Receive Records

Currently 95 percent of the information is transmitted by mail. Exceptions are in the case of stops or priority requests for information from law enforcement agencies. The use of priority response is carefully regulated by the ID Division.

This function is broken down into four subfunctions, namely: Open Mail, Sort, Prepare for Entry, and Enter/Verify Data.

The first three are self explanatory (3.1.1.1, 3.1.1.2, and 3.1.1.3). By Enter/Verify Data (3.1.1.4) is meant the usual conversion of alphanumeric data to computer readable form and its character by character verification. This is performed by keying in, optical character reader, etc.

3.1.2 Store Records

This function is divided into three subfunctions.

3.1.2.1 Comply With Regulations

Guidelines for the contents of the criminal file must be established and revised periodically to conform to current legal and judicial requirements, to Justice Department guidelines, and to national and FBI needs. These guidelines pertain to the information that can be added to the file as well as to the information that should be deleted.

This function is divided into two subfunctions. These are to satisfy legal and judicial requirements (3.1.2.1.1) and to follow FBI guidelines (3.1.2.1.2).

3.1.2.2 Enter in Index

An entry is established in the index for each new record.

3.1.2.3 File

Finally the record is filed.

3.1.3 Access Data

This function is divided into four subordinate functions, Identify File Key (3.1.3.1), Search Index (3.1.3.2), Retrieve Data (3.1.3.3), and Mark "Out of File" (if necessary) (3.1.3.4). The first three are self explanatory. If the retrieval method requires the physical removal of the record from the file, then a method for marking its absences is needed. On the other hand, if a duplicate image of the record is presented to the operator, then this function is not required.

Retrieval of data is further subdivided into three subfunctions: Retrieve f/p Cards (3.1.3.3.1), Retrieve Miscellaneous Records (3.1.3.3.2), and Retrieve Rap Sheets (3.1.3.3.3).

3.1.4 Update Records

This function breaks down into three subordinate functions.

3.1.4.1 Add Records

This function is required to accommodate new records. Its functional breakdown is identical to 3.1.2 Store Records.

3.1.4.2 Change Records

This function is divided into two subfunctions, the addition of new information to existing records such as dispositions and amending and correcting records found to be in error.

3.1.4.3 Delete Records

This function is divided into two subordinate functions, the removal of the index or pointer to the record (3.1.4.3.1) and the physical removal of the record itself if required (3.1.4.3.2).

If the file point is removed from the table of contents and the storage locations are marked as available for new storage, the record will be overwritten and destroyed as surely as if it were erased.

3.2 Monitor and Control File

This function is divisible into six subordinate functions. These are: Define Data Records, Perform Follow-Up, Provide Audit Trail, Manage File, Initialize System, and Ensure Data Integrity.

3.2.1 Define Data Records

This function is divided into three self-explanatory subfunctions which are: Define Indices (3.2.1.1), Define Formats (3.2.1.2), and Define Record Content (3.2.1.3).

3.2.2 Perform Follow-Up

This function is divided into two subordinate functions. The maintenance of current information (3.2.2.1) refers to seeking disposition on reported arrests and other revisions to the file that require the cooperation of outside agencies.

The handling of out-of-sequence transactions (3.2.2.2) refers to the possibility of two transactions referenced to the same individual becoming out of sequence due to the longer processing time of the first. This requires a follow-up report if an incomplete record on the individual was disseminated.

3.2.3 Provide Audit Trail

In order to trace the history of each record in the file, an audit trail is provided. This audit trail gives information on when each step in the processing of the record was taken.

This function is divided into three subordinate functions.

3.2.3.1 Assign Process Control Identifier

This function is self explanatory.

3.2.3.2 Provide Recovery Information After System Crash

In the event of a partial system failure, it is essential to know what transactions were being processed, what files were being accessed, and what other operations were in progress at the time of the partial failure. This information permits the efficient assessment of the damage and the restorage of the data base.

3.2.3.3 Monitor/Report Progress of Transactions

The location of transactions in the processing phase is required for effective data base management. The monitoring function is required in support of the reporting function and also for system self-evaluation.

3.2.4 Manage File

File management is divided into three self-explanatory subfunctions. These are: Define Storage Requirement (3.2.4.1), Mark Usable/Reusable Space (3.2.4.2), Allow for Growth (3.2.4.3).

3.2.5 Initialize System

This function is divided into four subordinate functions. The first, Power Up (3.2.5.1), is self explanatory. The second, Boot System (3.2.5.2), refers to the need to load a boot-strap loader. This has been automated in microprocessor and could be a candidate for automation.

Loading the operating system (3.2.5.3) can be performed at the console of the computer, or it can be remotely performed in a distributed system.

The loading of applications software (3.2.5.4) is also a candidate for automation.

3.2.6 Ensure Data Integrity

This function is divided into three subfunctions. These are: Ensure Physical Security, Ensure Data Quality, and Provide Backup.

3.2.6.1 Ensure Physical Security

The records should be secure from unauthorized access and from accidental destruction.

3.2.6.2 Ensure Data Quality

This function is broken down into two subordinate functions. These are to reject poor quality or incomplete transactions (3.2.6.2.1) and to verify the accuracy and appropriateness of each transaction (3.2.6.2.2).

3.2.6.2.1 Reject Poor Quality or Incomplete Transactions

If poor quality fingerprint cards are admitted to the file, they may never be matched to subsequent or prior submittals and false non-identifications may result.

3.2.6.2.2 Verify Accuracy and Appropriateness

This function is further divided into two subfunctions, one of which, Verify Accuracy (3.2.6.2.2.1), is a candidate for automation while the other, Verify Appropriateness (3.2.6.2.2.2), is not.

3.2.6.3 Provide Backup

This function divides into three subordinate functions, which are: Restore File After System Crash (3.2.6.3.1), Provide Emergency Backup Capabilities (3.2.6.3.2), and Provide "Out-of-File" Backup (3.2.6.3.3).

3.2.6.3.1 Restore File After System Crash

Of these three subordinate functions the first is self-explanatory.

3.2.6.3.2 Provide Emergency Backup Capabilities

An emergency backup capability for accessing the file information in the event that the primary access system has failed should be provided. If the availability of the system (mean time between failures plus mean time to repair) is sufficiently low, then no backup for routine operations may be necessary. However, the requirement for providing rapid identification in emergency situations will always be present and needs to be accommodated regardless of the condition of the system.

3.2.6.3.3 Provide "Out-of-File Backup" (if Required)

The need to access out-of-file information exists only in a system where the physical record is removed for access. Since more than one search can be actively using the file at the same time, the information must be available to all searchers. This function does not exist in a system where the physical record is not removed from the file for examination.

4.0 Executive Direction and Control

This function breaks down into eight subordinate functions. Only one of these is a candidate for automation. The monitoring of system performance and system workload is a readily automated function. The other seven functions are: Manage Human Resources, Manage Other Resources, Maintain System, Forecast Environment, Plan and Implement New Systems, Provide Identification Training for non-Bureau Personnel, and Determine Appropriate Identification Technology.

4.1 Manage Human Resources (Personnel Administration)

The management of human resources includes the administration and management of the personnel who operate the ID Division.

This function divides into the supervision of personnel (4.1.1), the estimation of requirements (4.1.2), the recruiting of personnel (4.1.3), and the training of personnel (4.1.4).

4.2 Manage Other Resources (Facilities and Budgets)

This function includes the management of facilities such as buildings and heating and ventilation systems as well as the preparation and management of the budget to operate these systems.

This function is divided into estimation of requirements (4.2.1), acquisition of facilities (4.2.2), and allocation of budget resources (4.2.3).

4.3 Maintain System

This function is divided into the performance of preventive maintenance (4.3.1), replacement of failed components (4.3.2), and the repair of failed components (4.3.3).

4.4 Monitor and Control System Performance and Workload

This function includes monitoring the routine performance of personnel, the automated system, and the system workload. It is divided into Fault Detection (4.4.1), Fault Isolation (4.4.2), Monitor

Queues (4.4.3), and Balance Load (4.4.4). Fault Isolation is further divided into hardware (4.4.2.1), software (4.4.2.2), and manual fault isolation (4.4.2.3).

4.5 Forecast Environment

It is important to monitor the changing climate for identification services and to consider the impact of these changes on equipment, personnel, and facilities.

This function is subdivided into the estimation of the impact of special requests (e.g. judicial, congressional, etc.) and the estimation of the impact of new requests.

4.5.1 Estimate Impact of Special Requests (e.g., Judicial, Congressional)

From time to time special requests are initiated by the courts, the Congress, and other agencies such as the White House. These non-routine operations can vary from the clearance of special visitors to the White House to the requirement to expunge large numbers of records from the criminal file due to a redefinition made by the courts of the appropriateness of the file. The ability to accurately estimate the impact of all special requests is important since it allows for the orderly management of resources and the estimation of budget impact of each special request.

4.5.2 Estimate Impact of New Requests

This function is self-explanatory.

4.6 Plan and Implement New Systems

As new technologies are considered and new systems are developed, it is important to keep in mind the massive transition problems associated with a huge data base and a large work force. The current conversion to automated systems (AIDS III) will continue for many years.

4.7 Provide ID Training for Foreign, Federal, State, and Local Agencies

The ID Division, as a service to the law enforcement community, provides training in fingerprint identification to foreign, federal, state, and local agencies. This results in personnel trained to take fingerprints that are sufficiently high in quality to be useful to the law enforcement community.

4.8 Determine Appropriate ID Technology (e.g., Fingerprint Matching)

In order to provide an identification service, an appropriate identification technology is needed and needs to be maintained. Currently, the ID Division employs fingerprint matching. Research in this area is continuing and, as better algorithms are developed, their use in the system should be considered.

Other techniques for positive identification should also be considered.

This function is subdivided into two subfunctions, the maintenance of operational capability and the research of new technologies.

REFERENCE

1. Automation of FBI Identification Functions Feasibility Study: Task Plan, Jet Propulsion Laboratory Internal Document, 5010-24, Pasadena, California, September 1979.

APPENDIX A

ACRONYMS

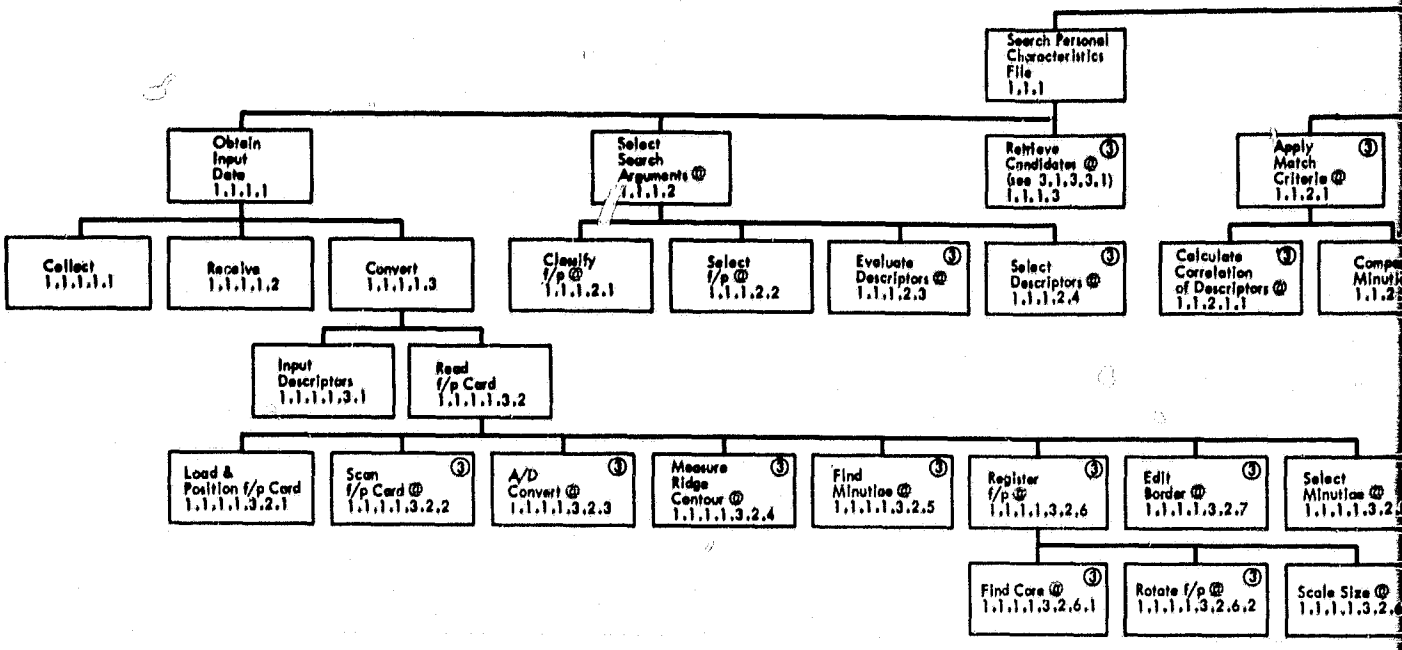
ACS	Automated Classification System
AFRS	Automated Fingerprint Reader System
AHU	Anti-Halation Underlayer
AIDS	Automated Identification Division System
ANS	Automated Name Search
ATS	Automated Technical Search
ATSPS	Automated Technical Search Pilot System
AUTOCOR	Automated Correspondence Station (part of AIDS)
AUTORESP	Automated Response Generation (part of AIDS)
A&R	Automation and Research Section of Identification Division
BER	Bit Error Rates
BLO	Blocking Out
CCA	Computerized Contributor Abbreviated Name
CCH	Computerized Criminal History (part of NCIC)
CCN	Computerized Criminal Name
CCNR	Computerized Criminal Name and Record (part of AIDS)
CCR	Computerized Criminal (Arrest) Record (part of AIDS)
CIR	Computerized Ident Response File (part of AIDS)
CLASS-A	Classification-A
CLASS-B	Classification-B
CLASS-C	Classification-C
CLCK	Classification Check
CNR	Computerized Non-Ident Response File
COA	Cutoff Age
CPU	Central Processing Unit

CRS	Computerized Record Sent File (part of AIDS)
CRT	Cathode Ray Tube
CSORT	Centerline Sort
DATE STP	Date Stamp, Count and Log
DBMS	Data Base Management System
DEDS	Data Entry and Display Subsystem (part of AIDS III)
DENT	Data Entry
DENT-A	Data Entry-Cards
DENT-B	Data Entry-Documents
DOA	Date of Arrest (on f/p card)
DOB	Date of Birth (on f/p card)
ECL	Emitter Coupled Logic
EMI	Electromagnetic Interference
ENC	Encode Input Data-Cards
ENCDOC	Encode Input Data-Documents
ENCK	Encode Check-Cards
ENDOCK	Encode Check-Documents
ERR	Update Error File
EYE	Color of Eyes (on f/p card)
FBI	Federal Bureau of Investigation
FEP	Front End Processor
FIFO	First-In-First-Out
FLAB	Film Lab Processing/Computer
FLOAD	Film Load
FPC	Fingerprint Classification
FPCS	Fingerprint Correspondence Section of the Identification Division
f/p	Fingerprint

GDBMS	General Purpose Data Base Management System
GEO	Geographic Location (on f/p card)
GPSS	General Purpose Simulation System
HAI	Color of Hair (on f/p card)
HGT	Height (on f/p card)
IBM	International Business Machines Corporation
ICI	Image Comparison Identification
ICRQ	Image Comparison Request
ICS	Image Comparison Subsystem (part of AIDS III, actually used for image retrieval for manual comparison)
ICV	Image Comparison Verification
ID, I.D.	Identification Division
IDENT	Identification
JPL	Jet Propulsion Laboratory
KIPS	Thousands of Instructions per Second (as executed by a computer)
LEAA	Law Enforcement Assistance Agency
MAIL	Open Mail and Sort
MFILM	Image Capture Microfilm
MIPS	Millions of Instructions per Second (as executed by a computer)
MMF	Minutiae Master File
MOE	Measures of Effectiveness
MTBF	Mean Time Between Failures
MTR	Master Transaction Record
MTTR	Mean Time to Repair
NAM	Name (on f/p card)
NASA	National Aeronautics and Space Administration
NCIC	National Crime Information Center

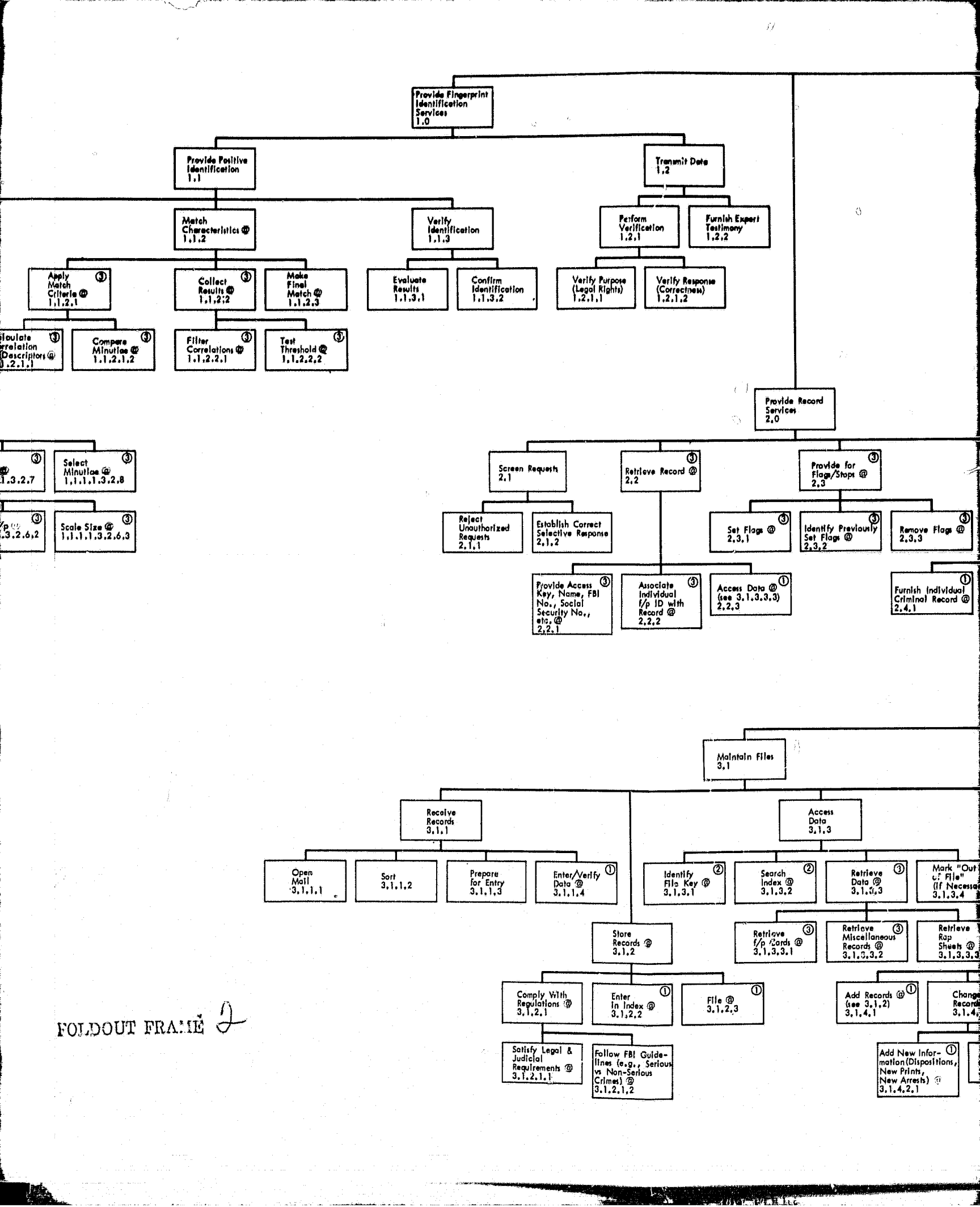
NCR	National Cash Register Company
OCA	Local Identification Number (on f/p card)
OCR	Optical Character Recognition
OMB	Office of Management and Budget
ORI	Originating Agency Identification Number (on f/p card)
PCN	Process Control Number
PICS	PCN and Image Capture Subsystem (part of AIDS III)
PMT	Photomultiplier Tubes
POB	Place of Birth (on f/p card)
QC	Quality Control
QUERY	On-Line Query
RAC	Race (on f/p card)
READ	Quality Control Check, Read, Annotate
RFI	Radio Frequency Interference
RH	Relative Humidity
RVF	Ridge Valley Filter
SACS	Semi-Automatic Classification System
SAR	Semi-Automatic Fingerprint Reader
SEAR	Search Review
SEX	Reported Sex of a Subject (on f/p card)
SID	State Identification Number
SKN	Skin Tone (on f/p card)
SOC	Social Security Number (on f/p card)
SPM	Search Processor Module
SS	System Supervisor Subsystem (part of AIDS III)
SSM	Subject Search Module
SSRG	Subject Search and Response Generation Subsystem (part of AIDS III)

TDFA	Top Down Functional Analysis
TFC	Technical File Conversion
TR	Transaction Record
TRC	Transaction Control File
TSS	Technical Search Subsystem (part of AIDS III)
TTL	Transistor - Transistor Logic
VDENT-A	Verify Data Entry-Cards
VDENT-B	Verify Data Entry-Documents
VLSI	Very Large Scale Integration
WAND	Wand Out of System



FOLDOUT FRAME 1

FOLDO



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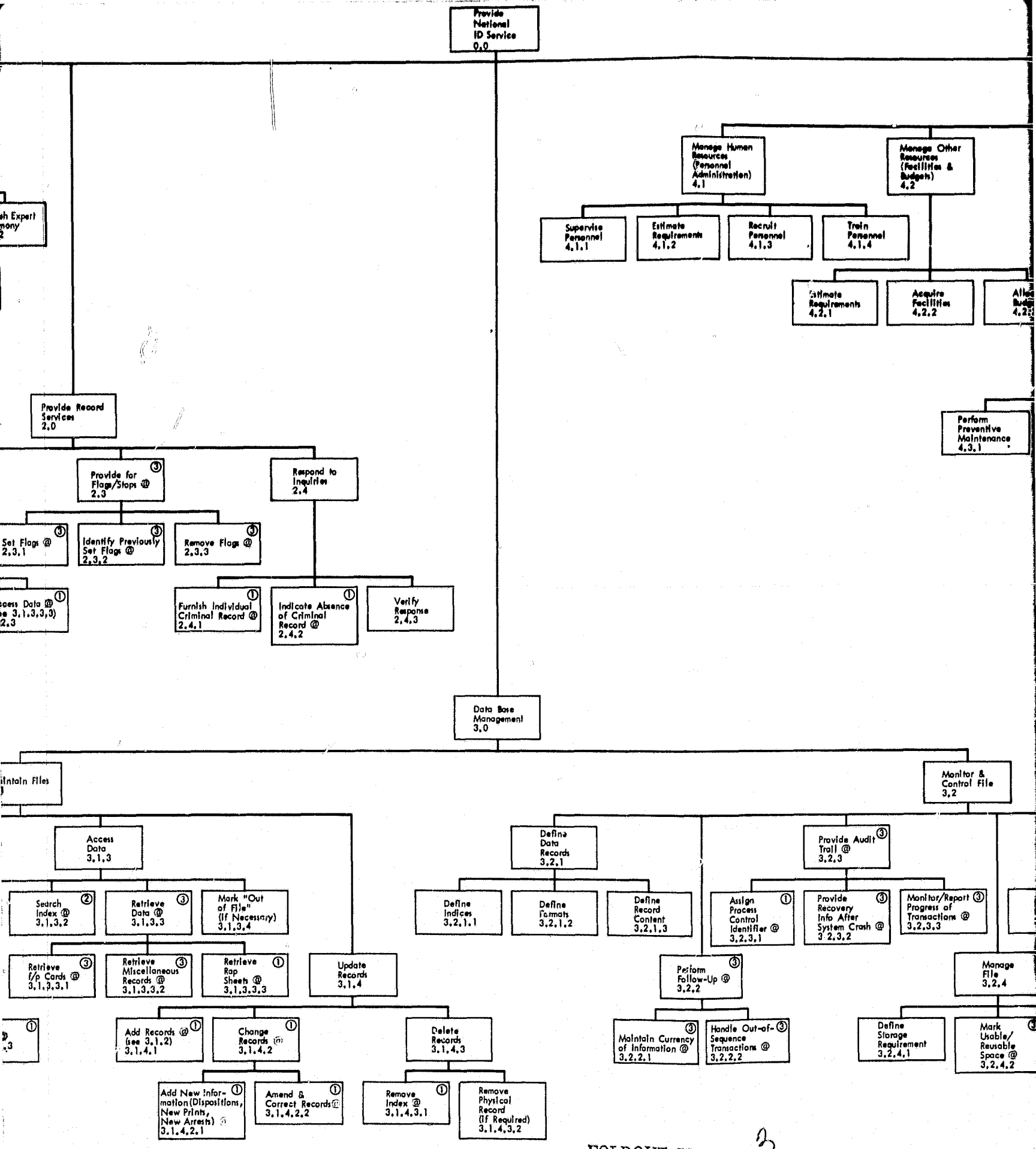

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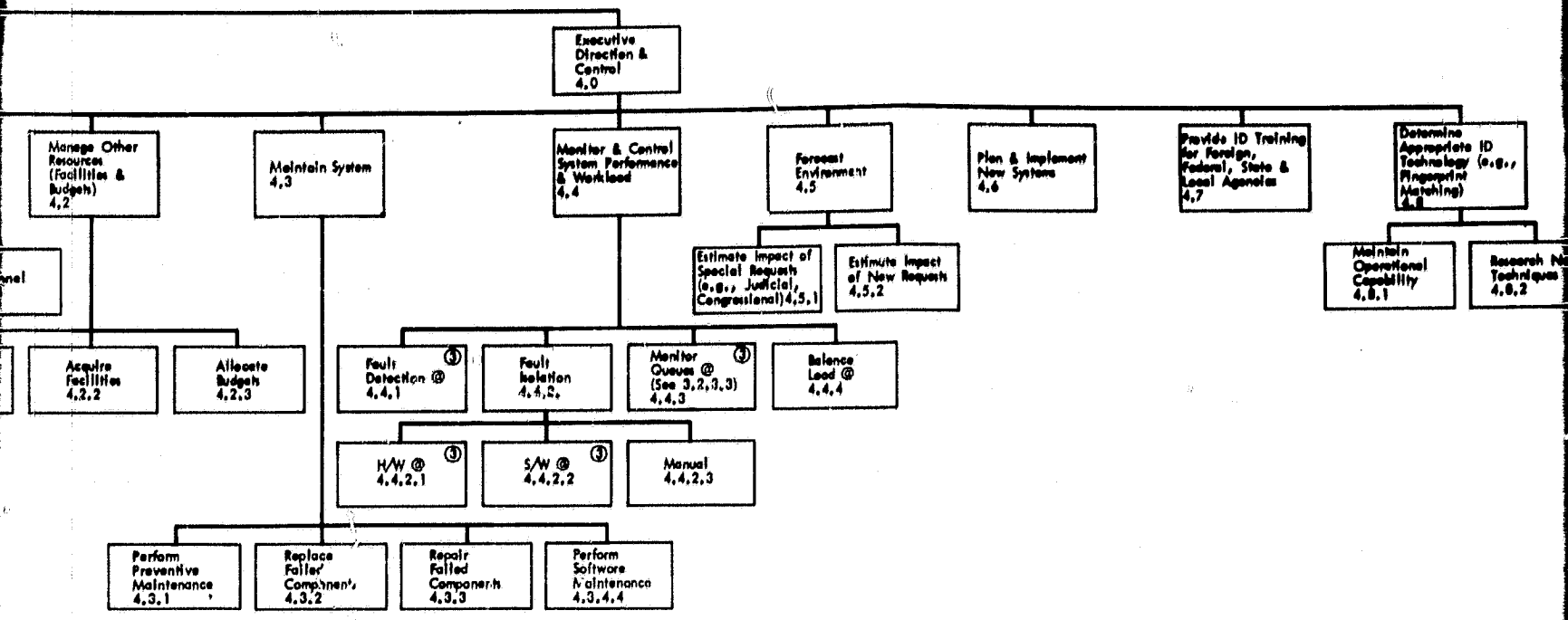

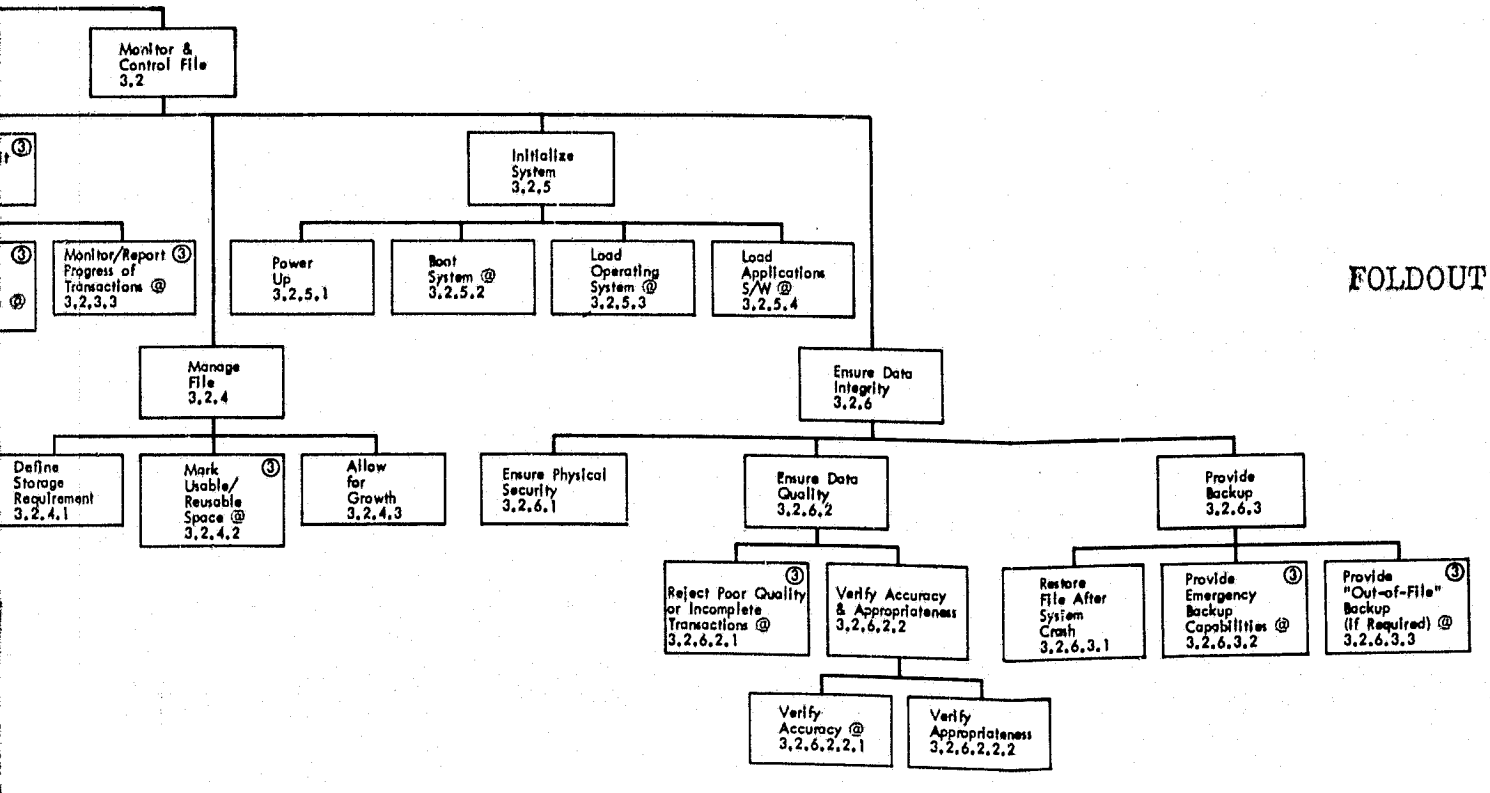

FOLDOUT FRAME 4